Practical Parasitology

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سنة ثالثة بكالوريوس بشري

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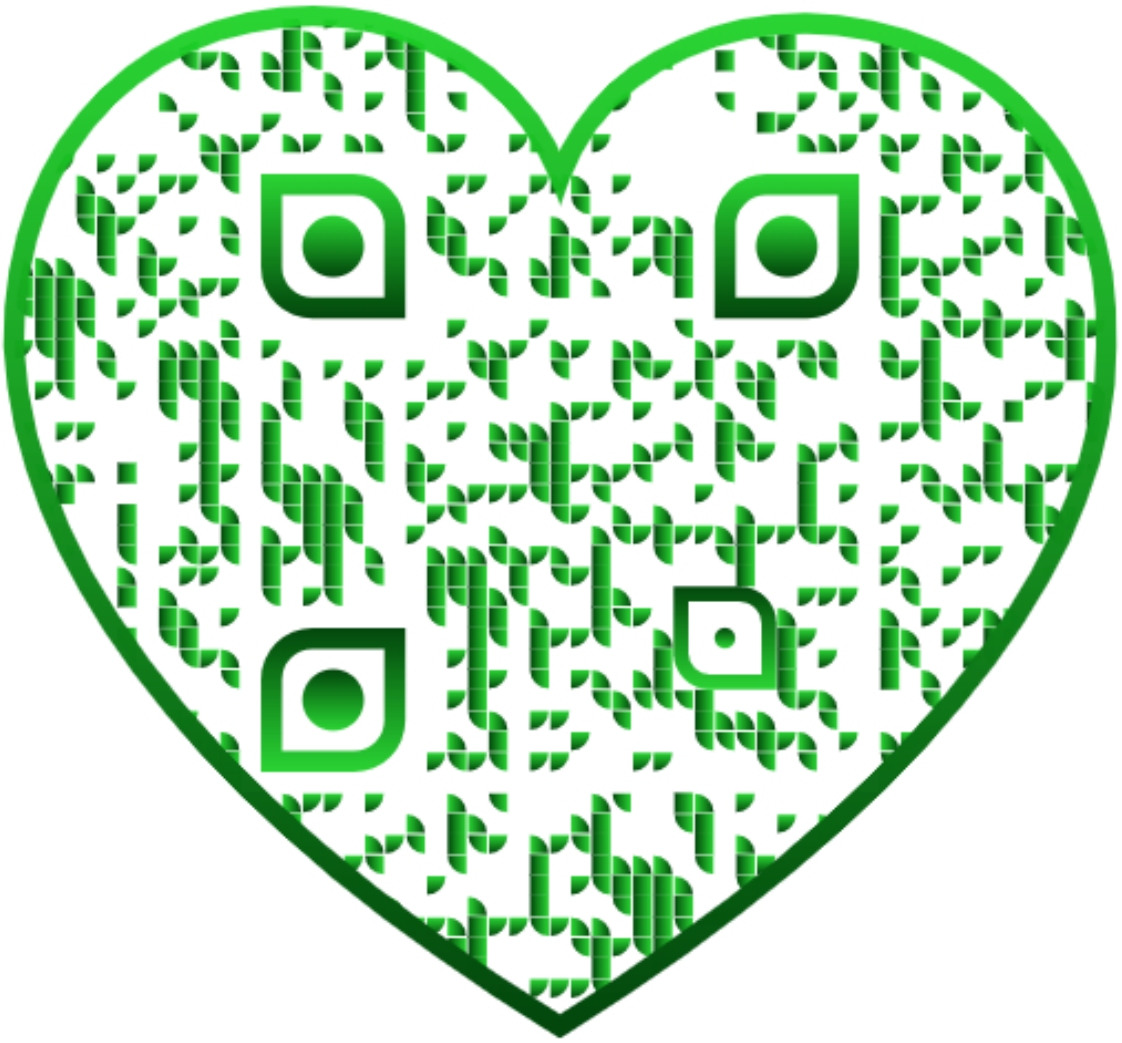

Practical Parasitology

❑ Parasitology

It is the study of parasites, their hosts, and the relationship between them.

- **Parasite**

A living organism which gets nourishment from another living organism where it lives is called parasite. They may be:

1. **Ectoparasite:** living on the surface of other organisms e.g. lice, ticks, mites, etc.
2. **Endoparasite:** live inside the body of other organisms, e.g. *Entamoeba histolytica*, *Ascaris lumbricoides*, etc.

❑ Parasitism

A form of symbiosis in which one organism (called parasite) benefits at the expense of another organism usually of different species(called host).

- **Host**

An organism which harbors the parasite. Host may be of following types:

1. **Definitive host:** when it harbors parasite in adult form or when parasite utilizes sexual method of reproduction.
2. **Intermediate host:** harbor's larval stages of parasite.
3. **Reservoir host:** which make parasite available for transmission to other hosts.

- **Vector**

- A vector is any agent (person, animal or microorganism) that carries and transmits an infectious pathogen into another living organism.

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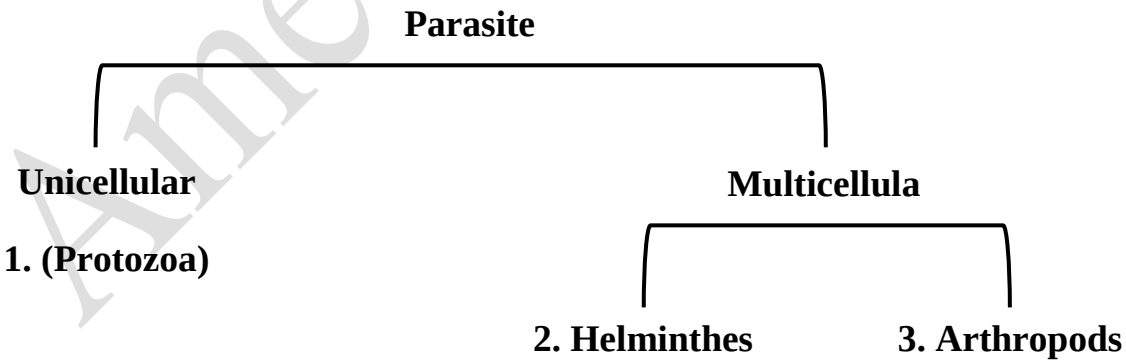
- Arthropods form a major group of disease vectors with mosquitoes, flies, sand flies, lice, fleas, ticks and mites transmitting a huge number of diseases.
- Many such vectors are haematophagous, which feed on blood at some or all stages of their lives. When the insects blood feed, the parasite enters the blood stream of the host. This can happen in different ways.
    - **Examples of vectors:**
        1. The *Anopheles* mosquito, a vector for Malaria.
        2. Pool feeders such as the sand fly and black fly, vectors for Leishmaniasis and Onchocerciasis respectively.

- **Source of infection**
    1. Ingestion.
    2. Arthropod bites.
    3. Penetration of intact skin or mucous membranes.
    4. Sexually.

- **Taxonomy and classification:**

  The classification of parasites according to number of cells:



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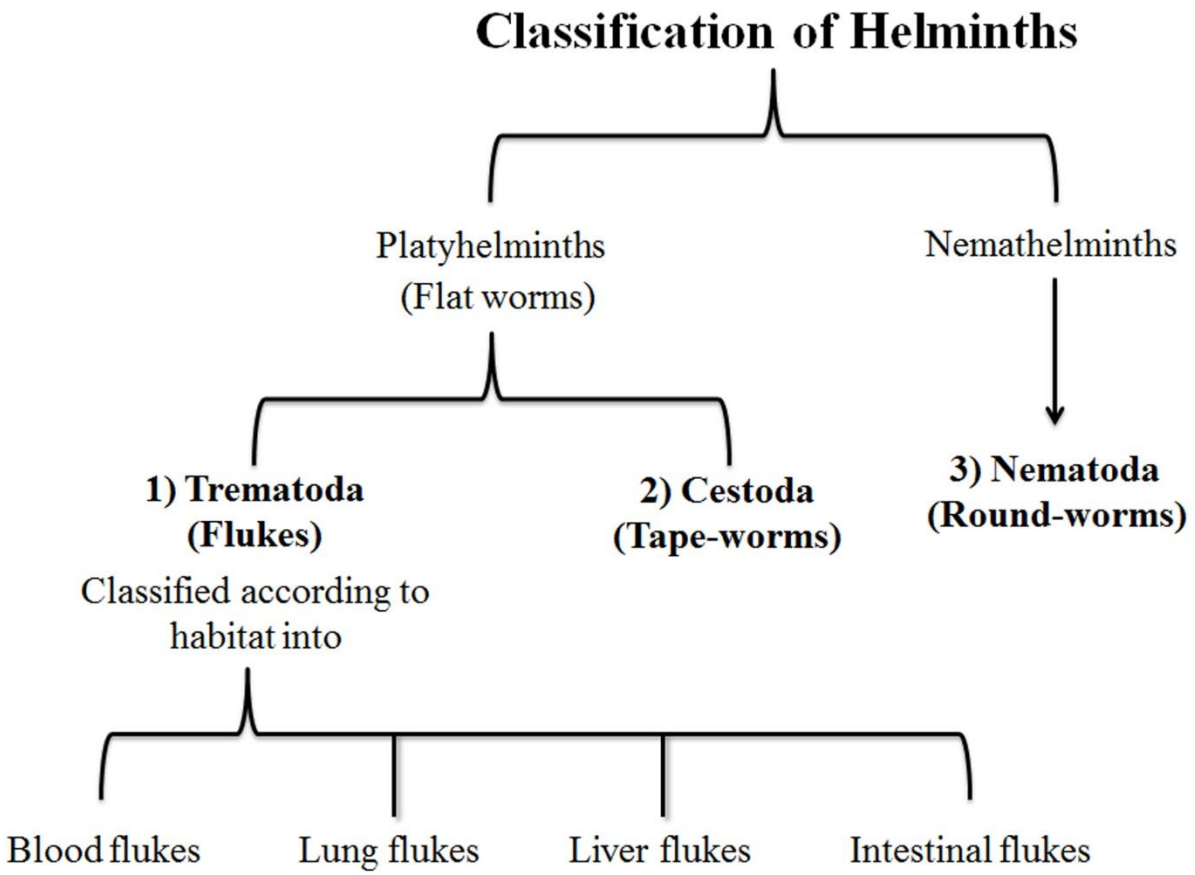
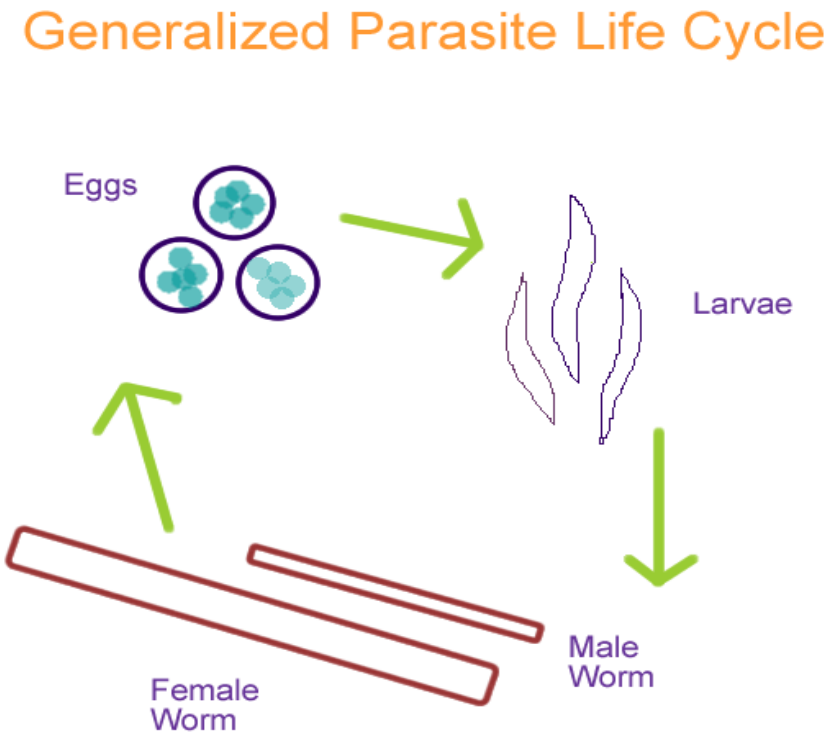
- **Classification of Hehminths:**



- **Characteristics of Helminths:**
  - Helminths are macroscopic, multicellular, eukaryotic worms.
  - They have well developed organ systems.
  - Life cycles are complex.
  - Intermediate hosts are often needed to support larval stages.
  - Intermediate host-which harbor asexual phase of parasite.
  - Definitive host-which harbor sexual phase of parasite.
  - Adult worms are either dioecious or monoecious.
  - Distribution is Worldwide.
  - An infection by a Helminth is known as helminthiasis, soil-transmitted helminthiasis, helminth infection or intestinal worm infection

- There are three groups of helminthes:
    - Cestodes (tapeworm).
    - Trematodes (fluke).
    - Nematodes (roundworm).

- **Overview of Generic Life Cycle**



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1. Trematodes

- **General characters of trematoda**

1. Leaf–like worms ,flattened dorsoventrally (except Schistosoma female).
2. With 2 or 3 suckers (oral, genital and ventral suckers).
3. Attach to host tissues via a ventral sucker to obtain nutrients.
4. They do not contain body cavity
5. Lack complete digestive tract
6. Geographical distribution limited because the intermediate host is limited.
7. A snail is generally intermediate hosts.
8. Grouped according to the site in the body they parasitize.
9. All trematode parasites are monoecious (hermaphrodite) except *Schistosoma* spp.

- **Classification of Trematodes according to habitat inside the human:**

1. **Liver (Hepatica) flukes:**
   - *Fasciola hepatica*
   - *Fasciola gigantica*
2. **Blood flukes:**
   - *Schistosoma haematobium*
   - *Schistosoma mansoni*
   - *Schistosoma japonicum*
3. **Intestinal flukes:**
   - *Heterophyes heterophyes*
4. **Lung flukes:**
   - *Paragonimus westermani*

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1. Liver (Hepatica) flukes

- ***Fasciola hepatica***
- ***Fasciola gigantica***

- **Scientific Classification**

  - Kingdom: Animal
  - Phylum: Platyhelminthes
  - Class: Trematoda
  - Genus: *Fasciola*
  - Species: *F. hepatica* and *F. gigantica*

Adult stage of *Fasciola* spp.:

Name	***Fasciola hepatica***	***Fasciola gigantica***
Definition	Sheep	Cattle liver flukes
Size	3 x 1 cm	6 x 1.5 cm
Lateral margins	Converging	Parallel
Suckers	Equal	Oral smaller than ventral
Shoulders	More prominent	Less prominent
Distribution	Latin America, Africa , Europe & China	Egypt , Africa & Far East
Disease	Fasciolasis (liver rot)	

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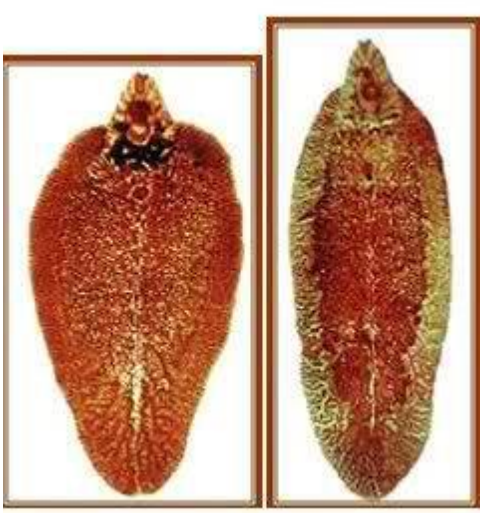
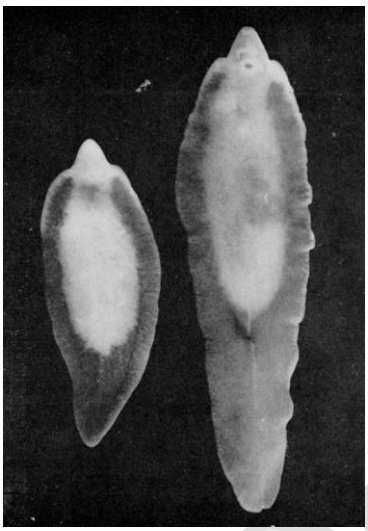
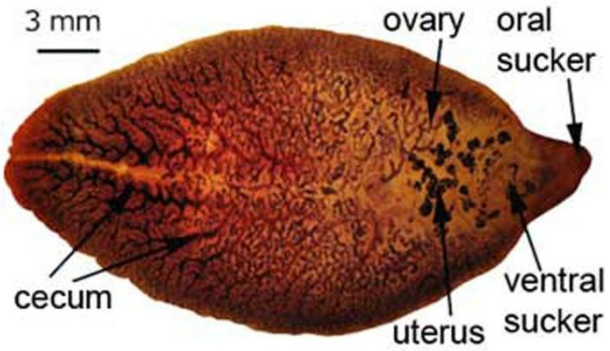
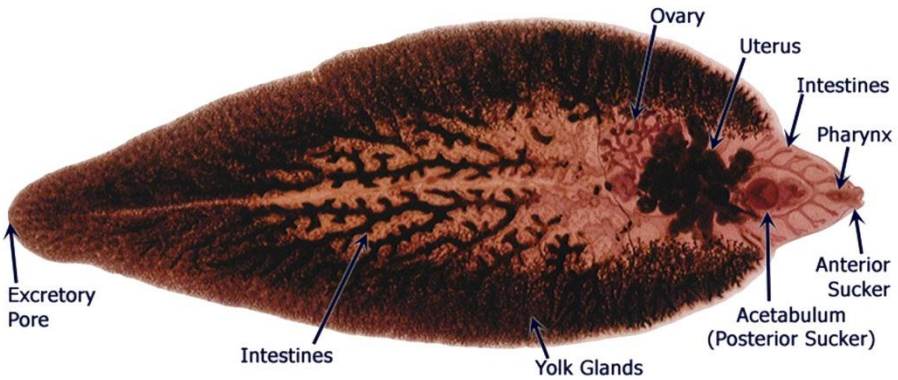




Living specimens are a grayish-brown in color

Morphology of *Fasciola* (adult worm)





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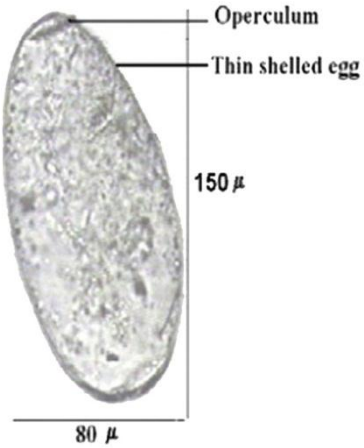
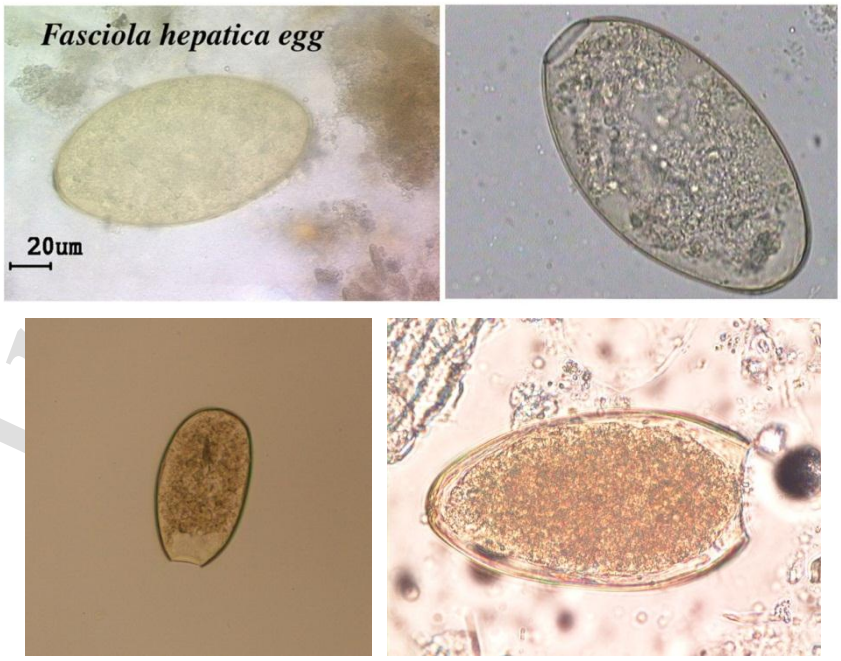
- **Egg of Fasciola species:**
  - Size:140x70 µm.
  - Shape: oval, operculated and thin shelled.
  - Color: yellowish brown in color
  - Content :immature ovum

Egg of *Fasciola hepatica*



Egg of *Fasciola hepatica*



- **Diagnostic Stage**

➢Egg

- The largest egg in trematodes.
- Operculated containing immature miracidium.
- Eggs hatches in fresh water after 2-3 weeks.

	Fasciola hepatica	***Fasciola gigantica***
Habitat	Adult lives in bile duct and liver	
Definitive host	Human (Human is an accidentally definitive host)	
Intermediate host	Snail *Lymnaea trunculata*	Snail *Lymnaea cailliaudi*
Reservoir host	Sheep	Cattle
Diagnostic Stage	Eggs in stool (Large operculated eggs with immature miracidium)	
Infective Stage	Encysted metacercaria on blades of aquatic plants or fresh water contaminated with encysted metacercaria	
Mode of infection	Eating raw aquatic plants with encysted metacercaria or eating raw sheep liver	

Lymnaea truncatula

Lymnaea cailliaudi

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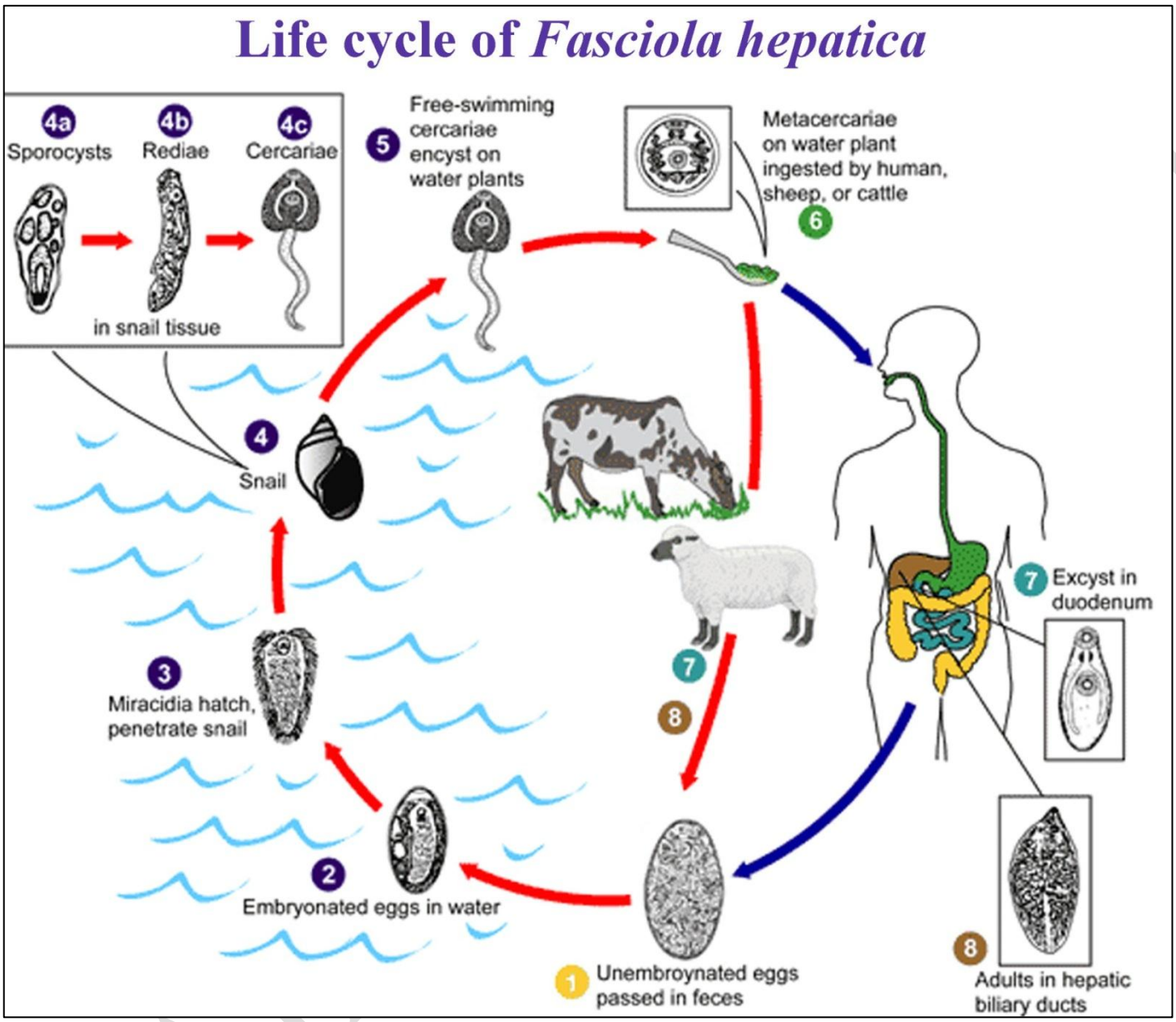
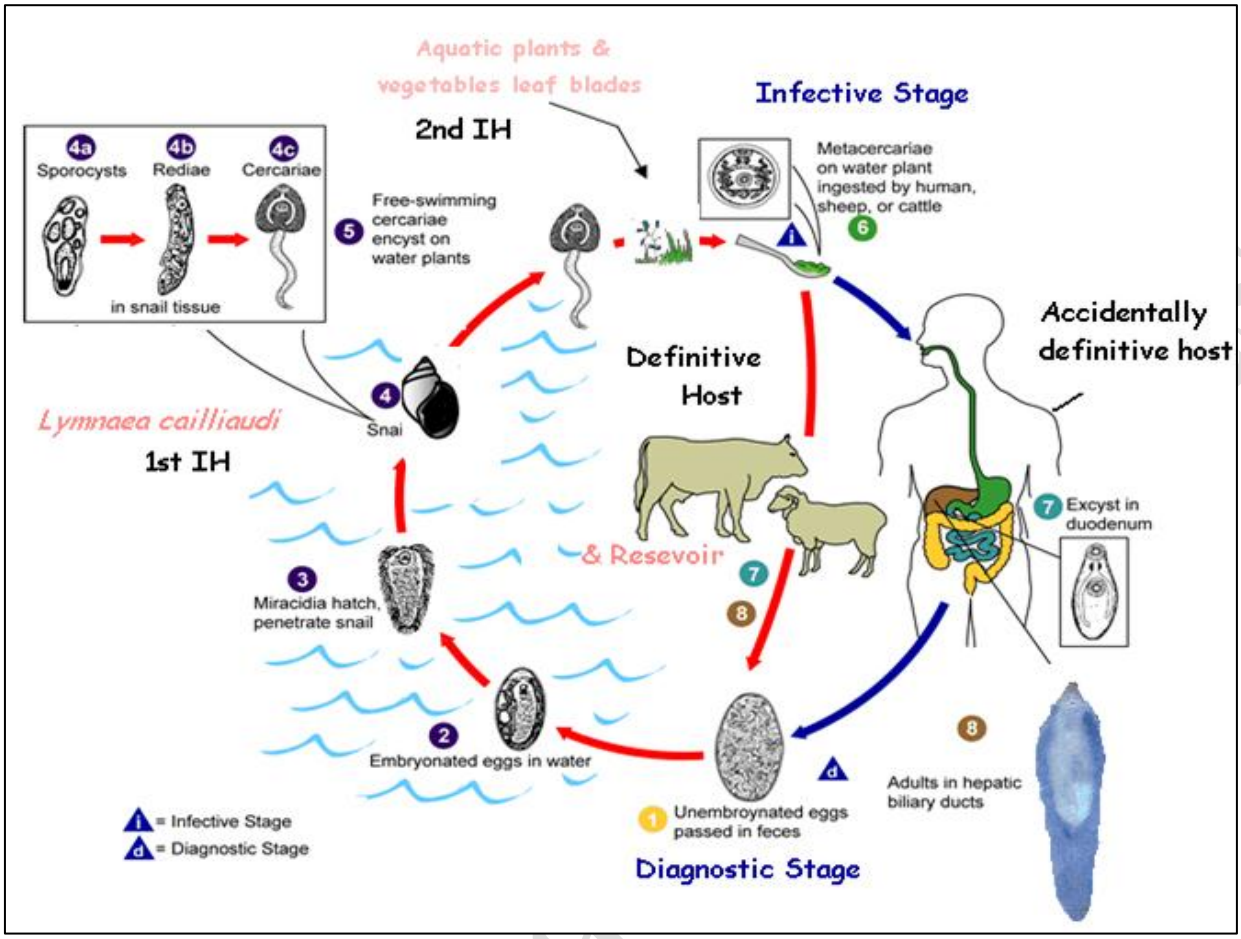
- **Life cycle** of ***Fasciola hepatica*:**



- **Life cycle of *Fasciola gigantica*:**



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2. Blood flukes

- ***Schistosoma haematobium***
- ***Schistosoma mansoni***
- ***Schistosoma japonicum***

- **Background**

  - **Schistosome is** a parasitic trematode worm contracted from infested water that is capable of causing liver, gastrointestinal tract and bladder disease.
  - Three main species of these trematode worms (blood flukes).

- **Scientific Classification:**

  - Kingdom: Animal
  - Phylum: Platyhelminthes
  - Class: Trematoda
  - Genus: *Schistosoma*
  - Species:
    1. *Schistosoma mansoi*
    2. *Schistosoma haematobium*
    3. *Schistosoma japonicum*

- ***Schistosoma* have exception than Trematodes:**

  1. Adult have separate sexes.
  2. Adult female is cylindrical.
  3. Intestinal caeca is reunite.
  4. Ova have spine.
  5. No Redia and metacercaria stages.

- **The habitat of the *Schistosoma* species:**

  1. *Schistosoma mansoi* in the veins of the rectum and the lower part of small intestine.
  2. *Schistosoma haematobium* in the veins of the urinary bladder.
  3. *Schistosoma japonicum* in the veins of the upper part of intestine.

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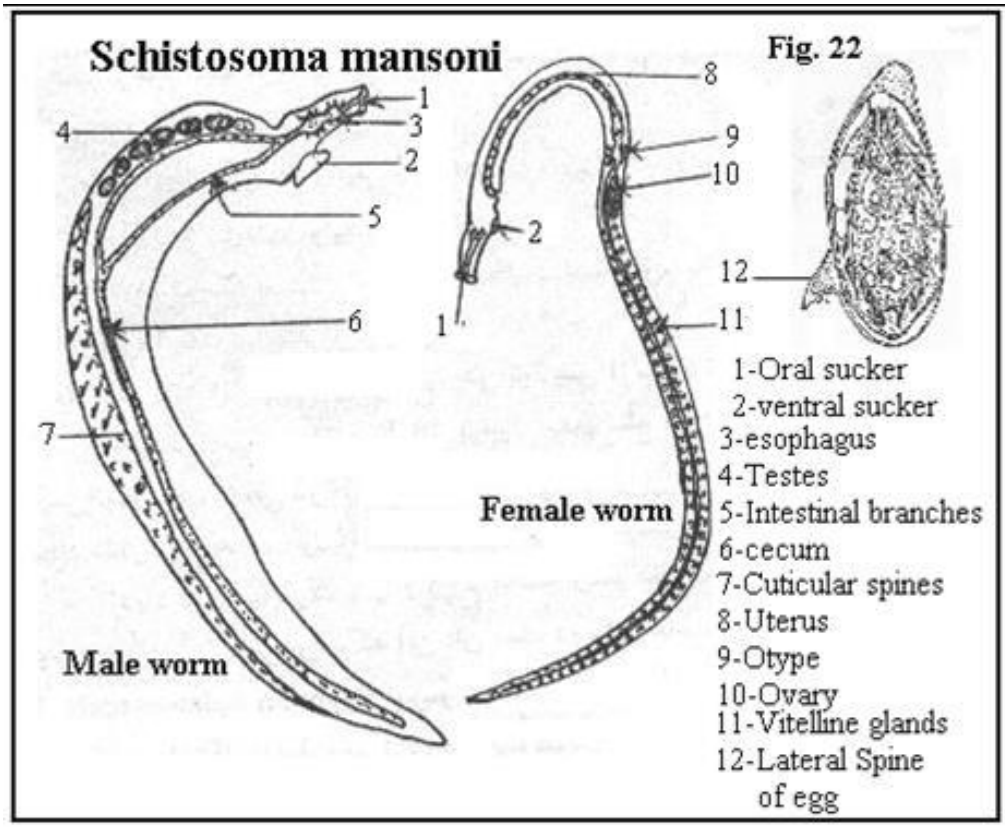
- **Morphology**



➢ **Adult male:**

- Flattened.
- Size: short 10 x 1 mm.
- Well–developed suckers.
- Posterior end is curved ventrally to form Gynaecophoric canal.
- Cuticle provided with tubercles.

➢ **Adult female:**

- Long and slender.
- Size: 20 x 0,2 mm.
- Suckers are weakly developed.
- Cylindrical with smooth cuticle.

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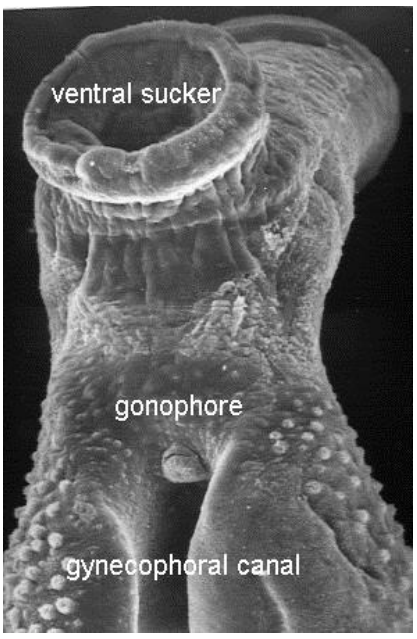
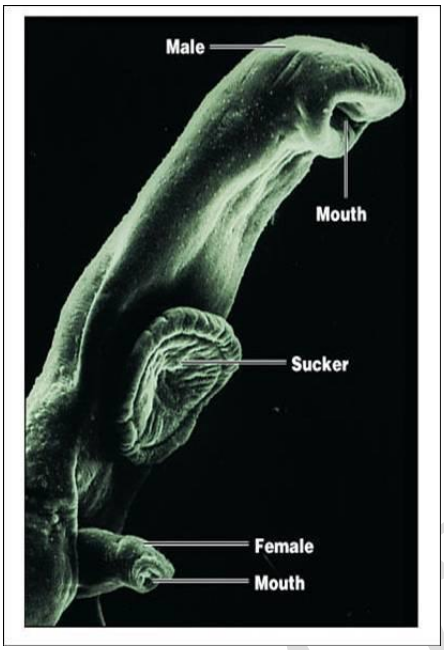
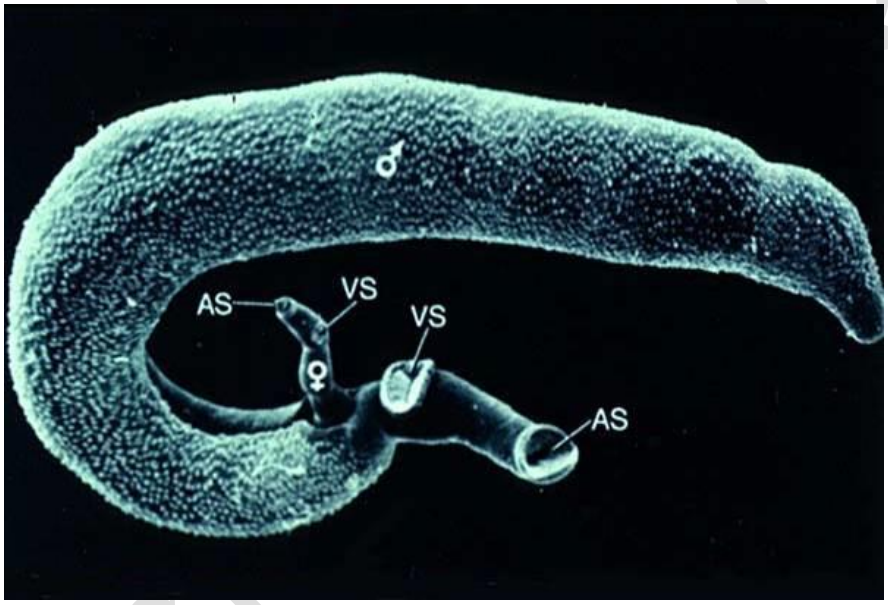
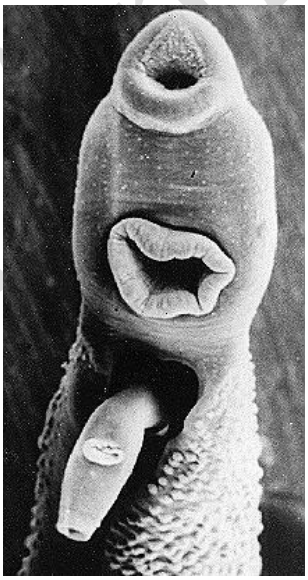
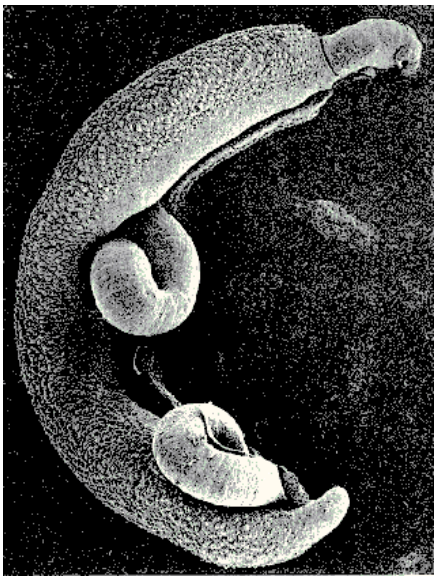
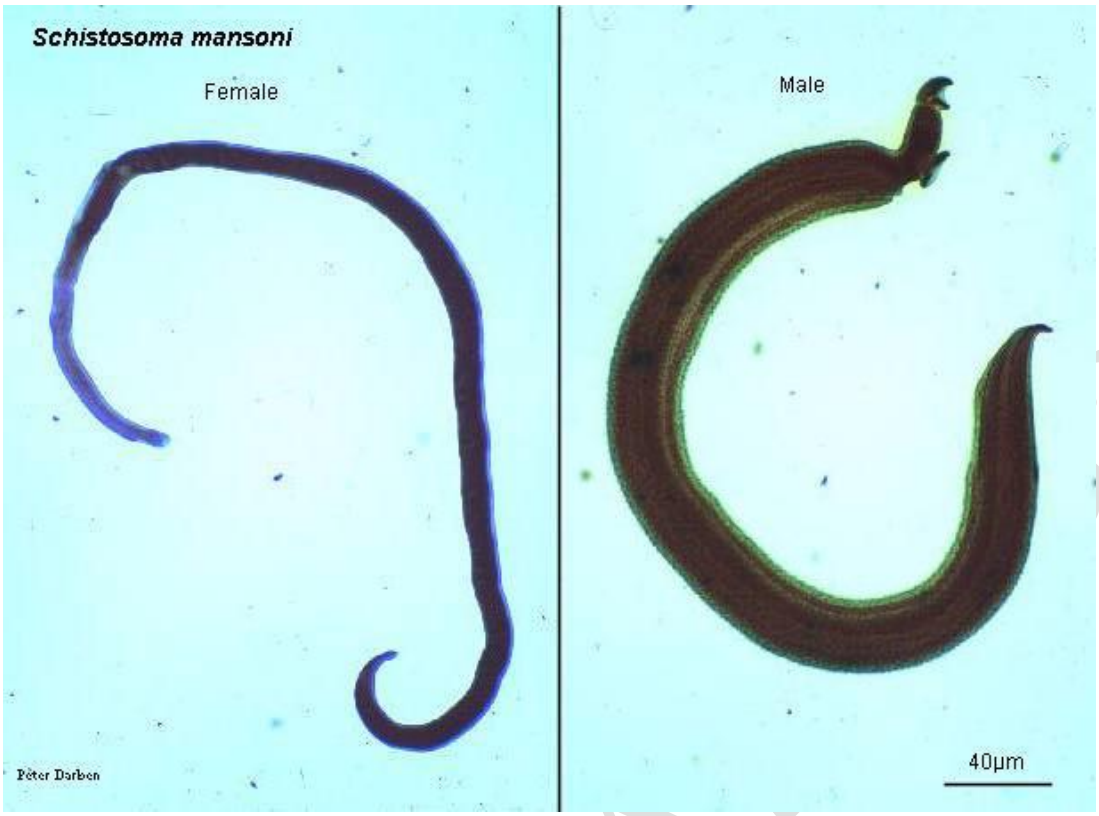

ventral sucker
gonophore
gynecophoral canal


Male
Mouth
Sucker
Female
Mouth


♂
AS
VS
VS
♀
AS



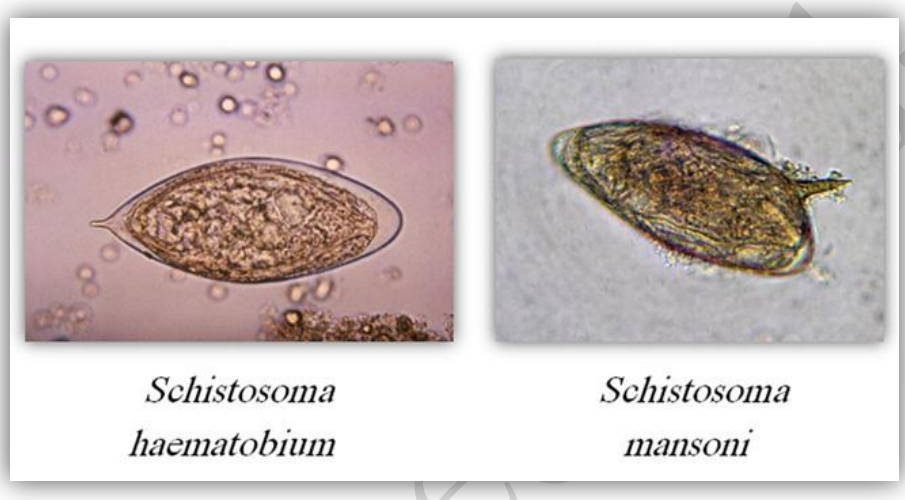



Schistosoma mansoni
Female
Male
Peter Darben
40µm

Schistosoma japonicum
Female
Male
Peter Darben
1mm

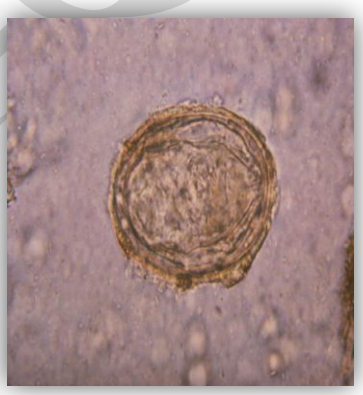
- **Eggs**

	Schistosoma mansoni	***Schistosoma haematobium***	***Schistosoma japonicum***
Size:	150 x 60 µm	140 x 60 µm	80 x 60 µm
Shape:	Oval,with one well rounded pole and one conical pole.	Oval, with one well rounded pole.	Oval, almost round.
Spine:	Lateral	Terminal	-
Content:	Miracidium	Miracidium	Miracidium
Color:	Translucent	Translucent	Translucent



Schistosoma haematobium

Schistosoma mansoni



Schistosoma japonicum

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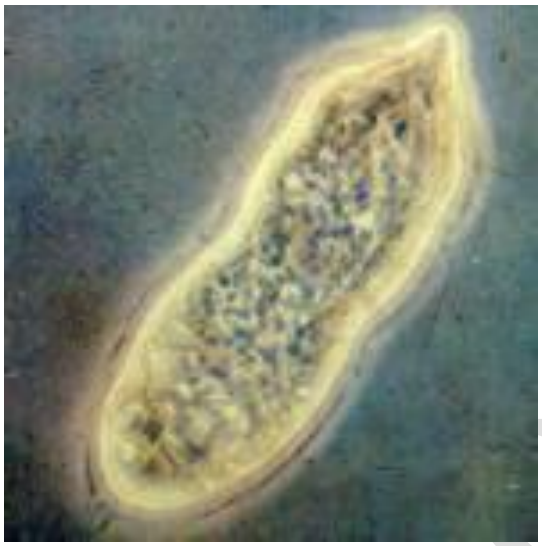
➢ Miracidium and Cercaria



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- **Disease**
  - They caused **Schistosomiasis**.
  - Schistosomiasis, also known as bilharzia or "snail fever", is a disease caused by parasitic flatworms called schistosomes. The urinary tract or the intestines may be infected.
  - Water-borne parasitic helminth.
- **Mode of infection:**
  - Infective stage (cecariae) penetrates the skin.
- **Definitive host:** Human
- **Intermediate host:** Snail
  - *Biomphalaria alexandrina* in case *S. mansoni*.
  - *Bulinus trancatus* in case *S. haematobium*.
  - *Oncomelania* in case *S.japonicum*.
- **Infective stage**:
  - Furccercus cercaria.

Diagnostic stage: Eggs.

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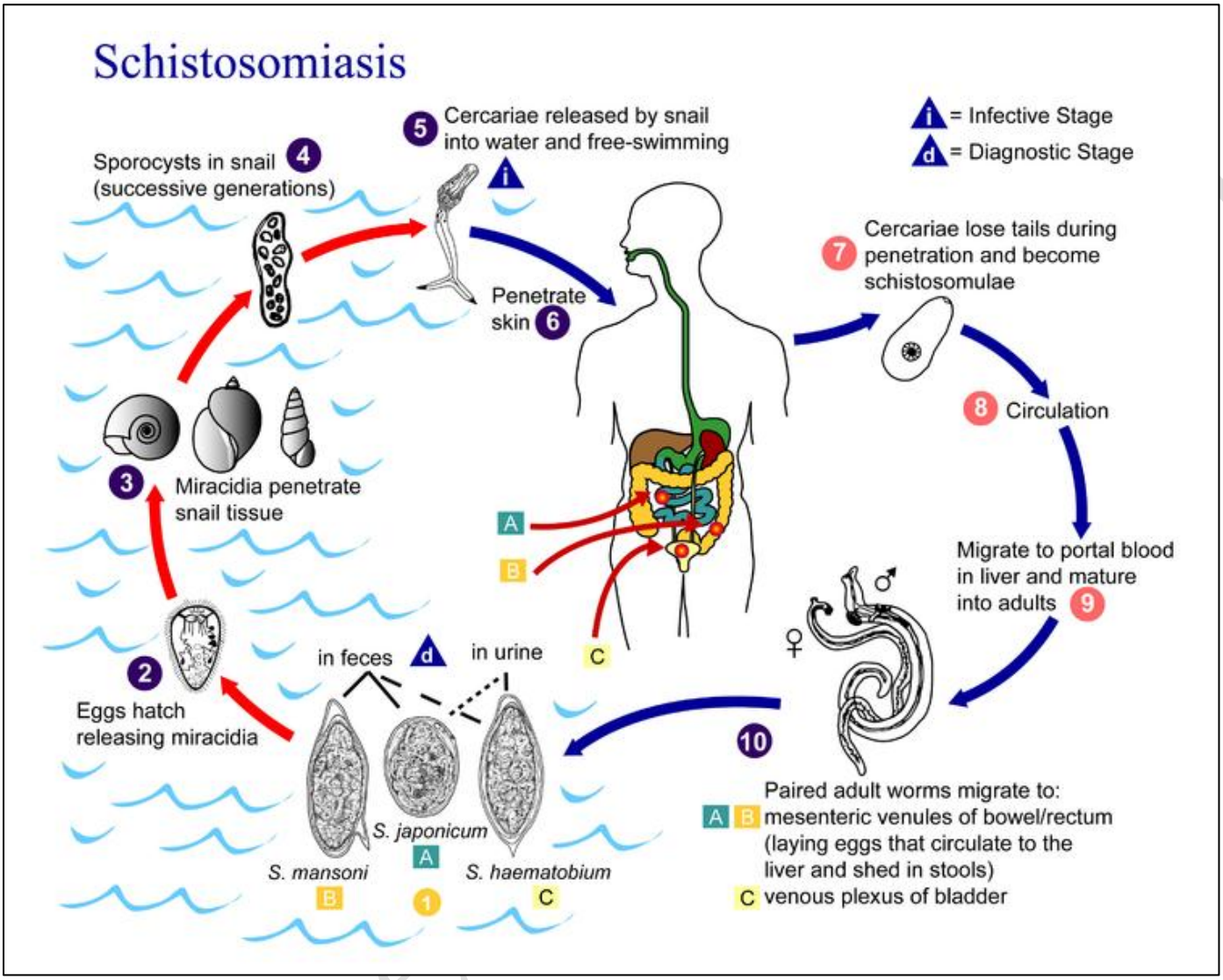
- **Life cycle**


Schistosomiasis
i = Infective Stage
d = Diagnostic Stage
5 Cercariae released by snail into water and free-swimming
Sporocysts in snail 4 (successive generations)
Penetrate skin 6
7 Cercariae lose tails during penetration and become schistosomulae
8 Circulation
3 Miracidia penetrate snail tissue
A
B
C
Migrate to portal blood in liver and mature into adults 9
in feces d in urine
2 Eggs hatch releasing miracidia
10
Paired adult worms migrate to:
A B mesenteric venules of bowel/rectum (laying eggs that circulate to the liver and shed in stools)
C venous plexus of bladder
S. japonicum A
S. mansoni B
S. haematobium C
1

❑ **Compare between *Schistosoma mansoni* and *Schistosoma hematobium***

	Schistosoma mansoni	***Schistosoma hematobium***
Location	Veins of **large intestine**, colon (lower mesentric vein	Veins of **urinary** bladder (venous plexus of urinary bladder
Interm. host	*Biomphalaria alexandrina*	*Bulinus truncatus*
Diagnosis	*Eggs in stool*	*Eggs in urine*
Infective stage	*Cercariae*	*Cercariae*
Mode of transmission	Direct skin penetration of cercariae during swimming	
Disease:	**Intestinal** Bilharziasis	**Urinary** Bilharziasis

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2. Cestodes (Tape-worms)

- **General characters of Cestodes**
  1. Flat, segmented intestinal parasites.
  2. All tapeworms lack digestive systems.
  3. Monoecious (each segment) contains reproductive system highly developed.
  4. All species are parasitic.
  5. All possess the same general body plan.

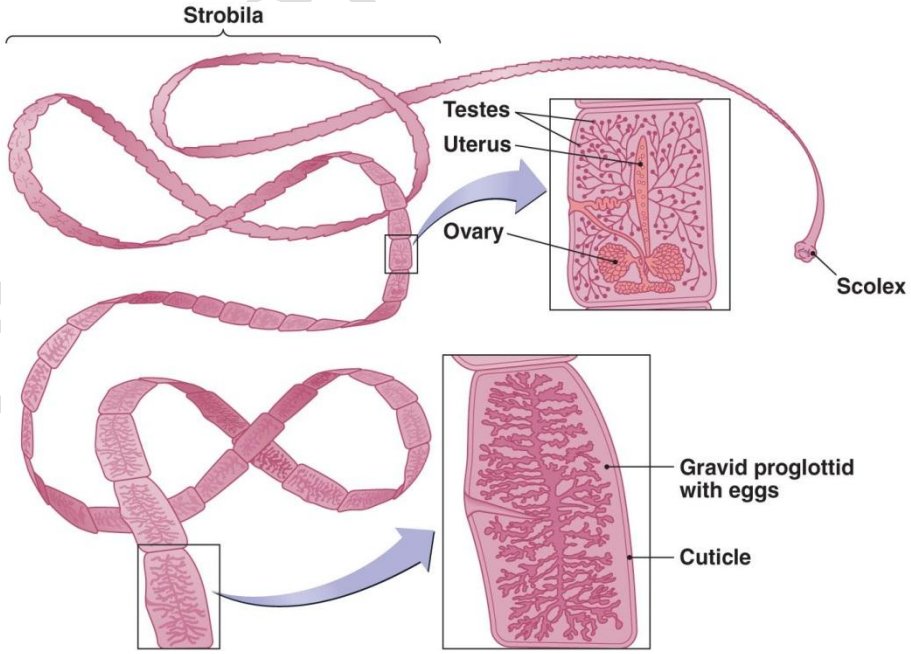
- **Morphology of worm:**

  Three regions of worm body:

  a. Scolex: suckers, hooklets, grooves.

  b. Neck: germinal portion.

  c. Strobila: immature, mature, gravid proglottids (segments).



Tapeworm morphology

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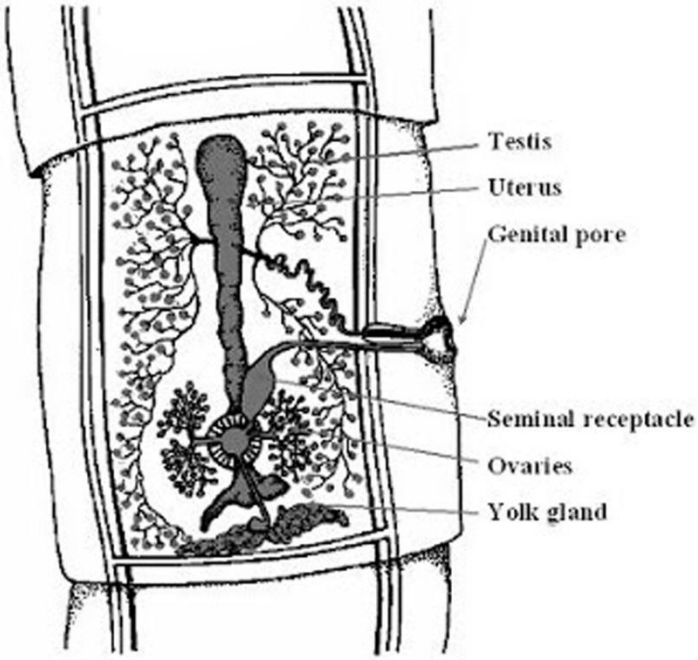
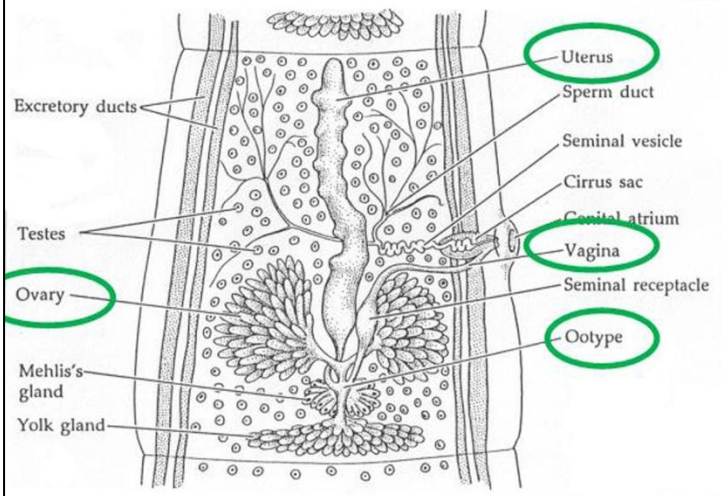
Structure of sexual mature proglottid of cestode

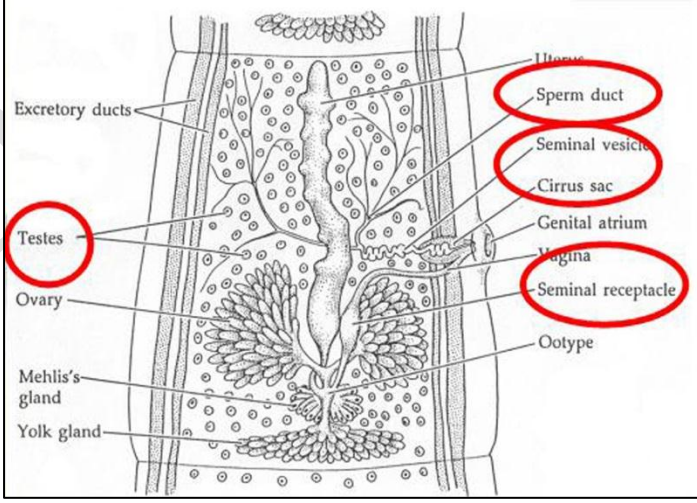


Structure of muture proglottid of cestode



For the female parts, it comprises of:

- **The ovaries**
- **Oviduct**
- **Ootype**
- **The uterus (extend from the ootype)**
- **Vagina**



The male part of the tapeworm consists of:

- **Many testes**
- **Single-coiled sperm duct**
- **Cirrus**
- **Genital atrium**

- **Classification of Cestode :**

1. **Pseudophyllidean:**
   - *Diphyllobothrium latum*
2. **Cyclophllidean (intestinal cestode):**
   - *Teania saginata*
   - *Teania solum*
   - *Hymenolepis nana*
   - *Hymenolepis diminuta*
   - *Dipylidium caninum*
3. **Systemic cestode:**
   - *Echinococcus granulosus*

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❑ Cyclophllidean (intestinal cestode)

➢ *Taenia saginata*.

- **Scientific Classification**
  - Kingdom: Animal
  - Subkingdom: Metazoa
  - Phylum: Platyhelminthes
  - Class: Cestoidea
  - Subclass: Cestoda
  - Order: Cyclophyllidea
  - Family: Taeniidae
  - Genus: *Taenia*
  - Species: *Taenia saginata*.
- **Disease:**
  - Taeniasis *saginata* (a type of helminthiasis) or beef tape-worm infection.
  - Cysticercosis in cattle.
- **Habitat:**
  - In ileum of small intestine of man only.
- **Morphology:**

➢ **Adult worm of *Taenia saginata***

- Size: 4 – 10 meters in length.

1. Scolex:

- Globular with 4 suckers (Cup Shaped).
- No rostellum, or hooks.

Head of *Taenia*

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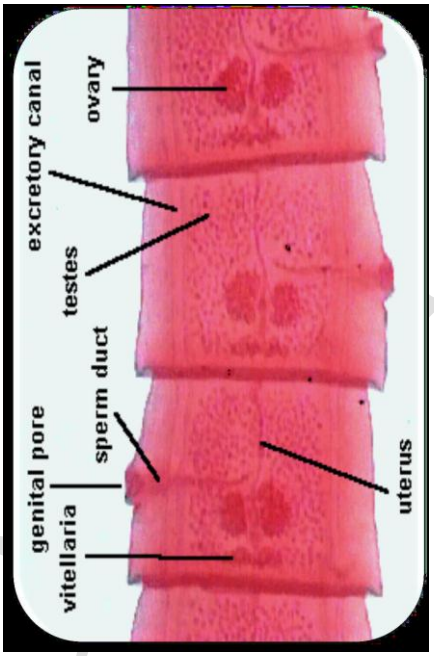
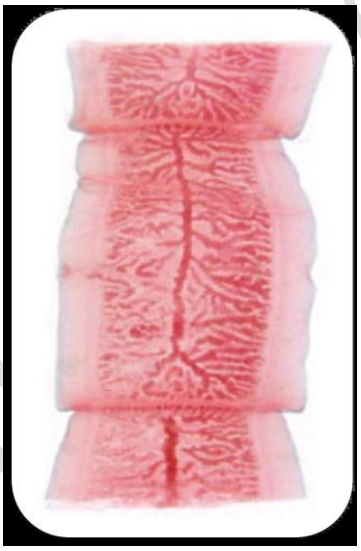
2. **Strobila (about 2000 segments)**
   - **Consists of:**
     a) **Immature segments:**
        - Broader than long.
        - Lack genital organs (Undifferentiated).



     b) **Mature segments: (Squarish)**
        - Contains genital organs.
        - Testes: 300- 400 testes.
        - Ovary: Bilobed in the posterior part.
        - Uterus: Longitudinal tube.
        - Vitelline gland: posterior compact mass.
        - Common genital pore: Marginal.

     c) **Gravid segments:**
        - Longer than broader.
        - Uterus with lateral branches on each side (15-30).



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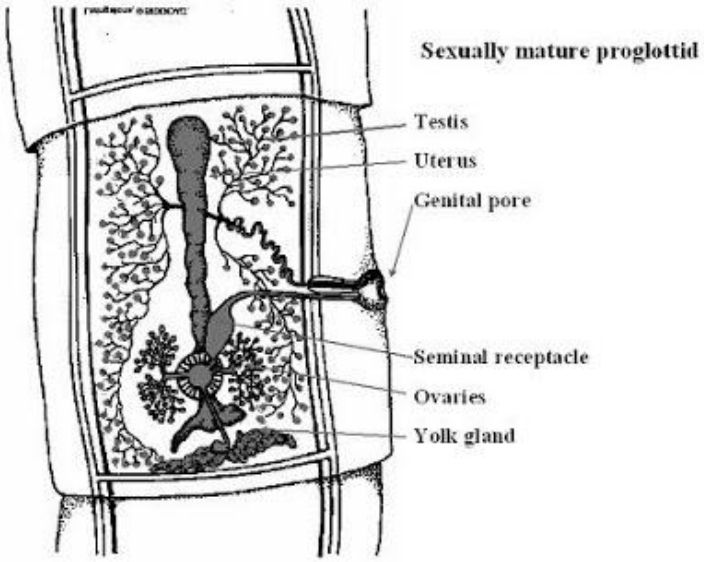
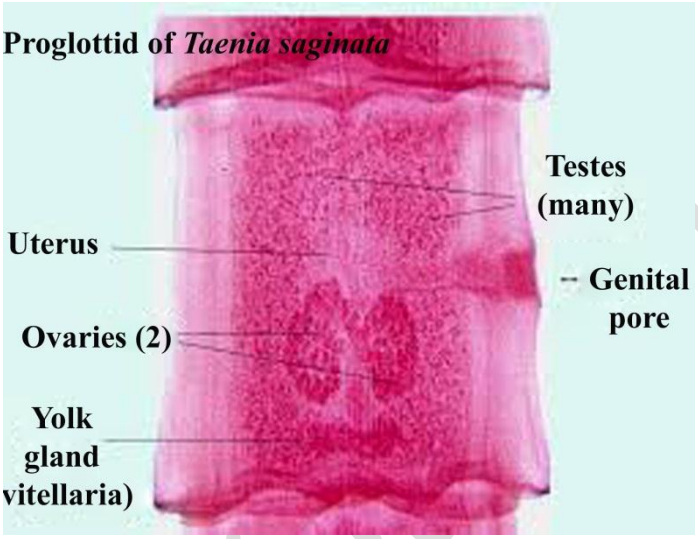
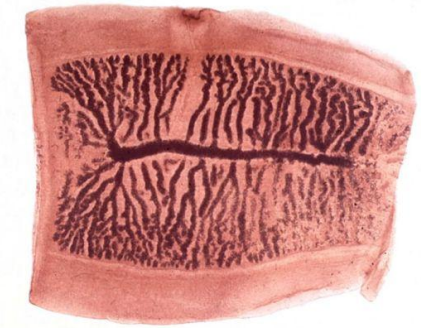
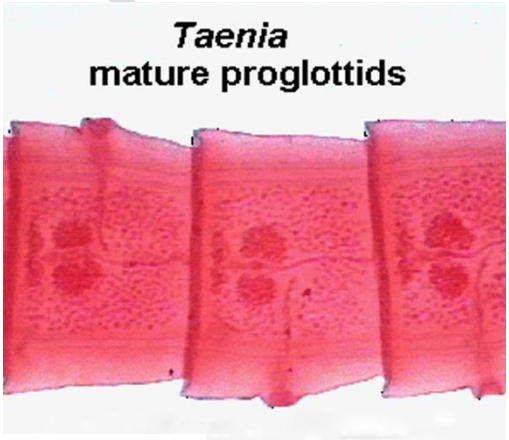


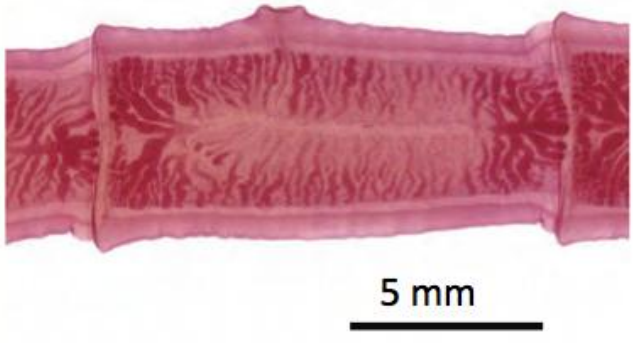


Beef Tapeworm

- Uterine branches in proglottid

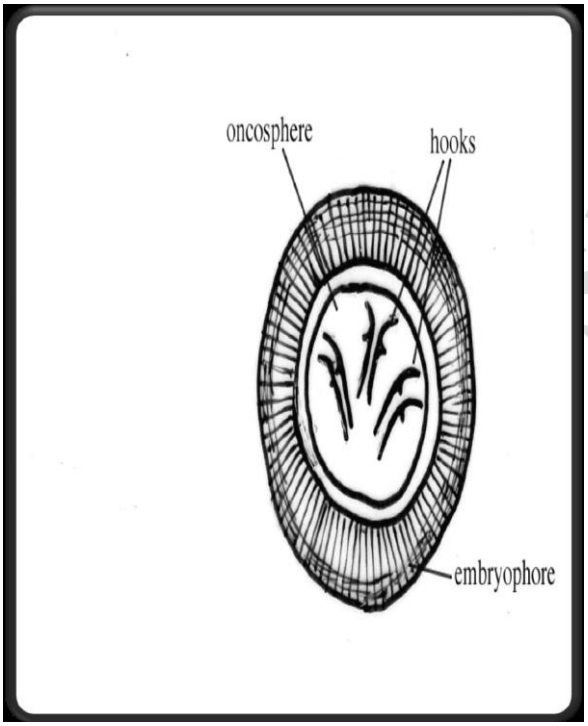






Proglottid of *Taenia saginata*

- **Egg of *Taenia saginata***:
  - Size: 40 µm.
  - Shape: Rounded with radially striated shell.
  - Color: Yellowish brown.
  - Content: Hexacanth onchosphere (6-hooked embryo).



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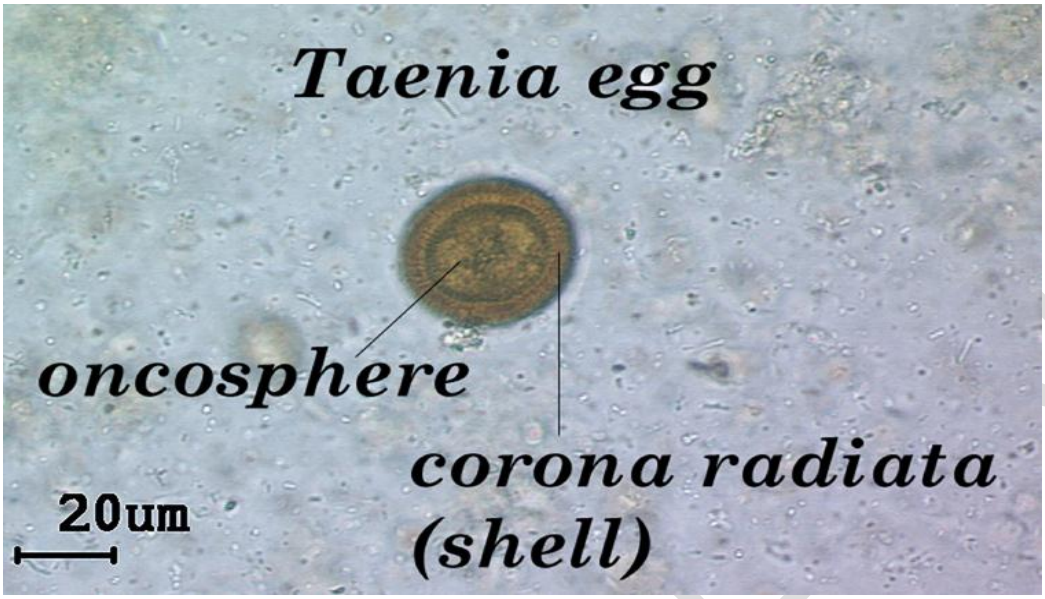
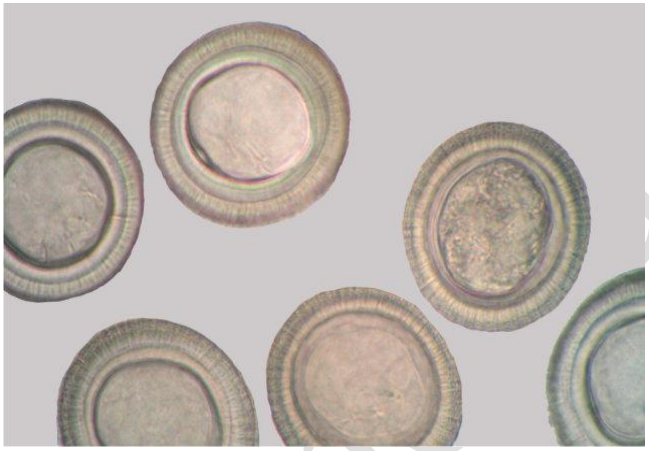
Eggs of *Teania* spp.





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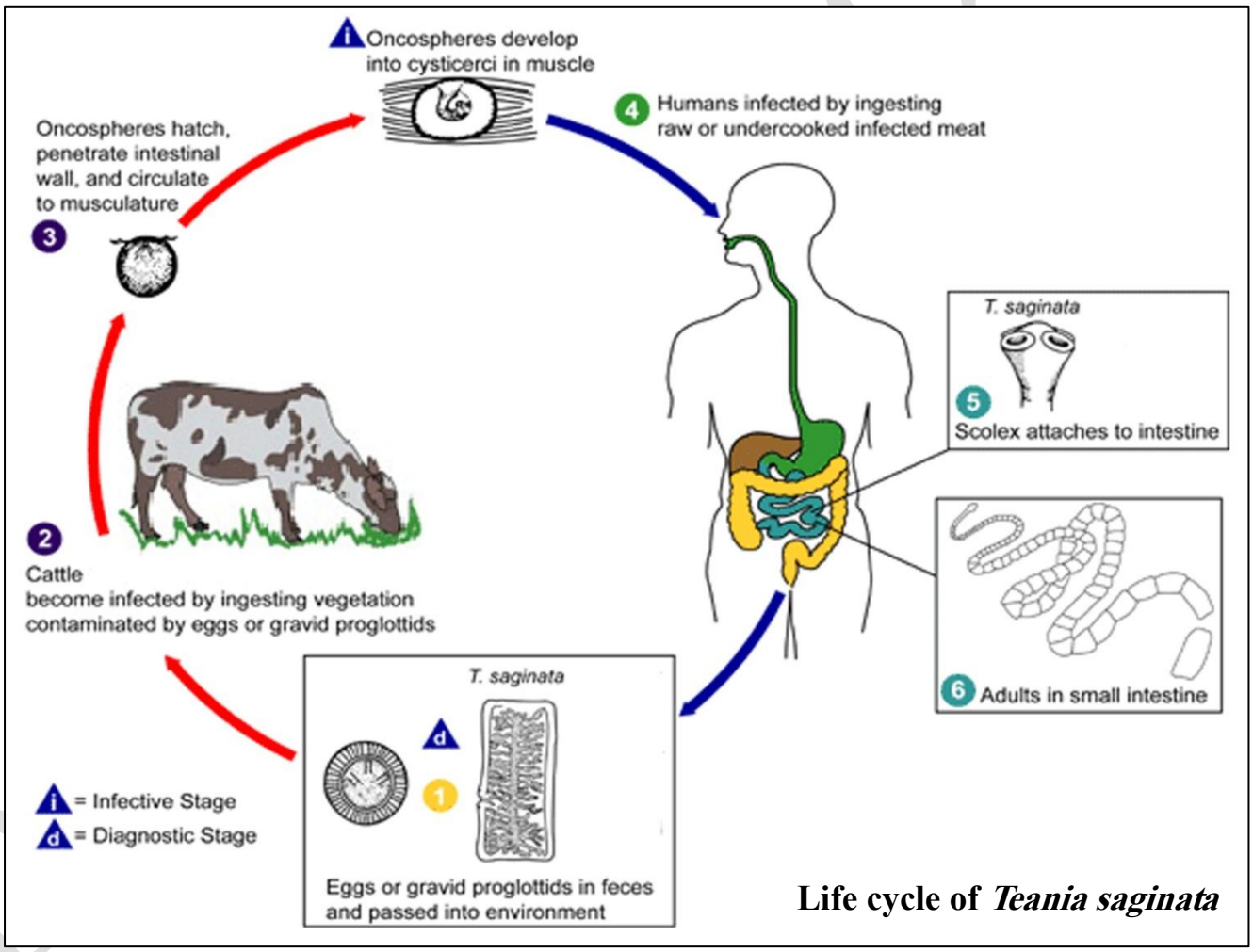
➢ **Larva of *Taenia saginata***:

- Cysticercus bovis (Bladder worm)
  - Size: 10 mm. Shape: Oval.
  - Scolex: Invaginated and carries 4 suckers.

▪ **Live cycle:**


1 Oncospheres develop into cysticerci in muscle
2 Cattle become infected by ingesting vegetation contaminated by eggs or gravid proglottids
3 Oncospheres hatch, penetrate intestinal wall, and circulate to musculature
4 Humans infected by ingesting raw or undercooked infected meat
5 Scolex attaches to intestine
T. saginata
6 Adults in small intestine
T. saginata
d
1
Eggs or gravid proglottids in feces and passed into environment
i = Infective Stage
d = Diagnostic Stage

Life cycle of *Teania saginata*

- **Mode of infection:**
  - By eating undercooked or raw meat (beef) containing infective stage (cysticercus bovis).
- **Infective stage:**
  - Cysticercus bovis (Larva of *Taenia saginata*).
- **Diagnostic stage:**
  - Eggs and gravid segments.
- **Definitive host:**
  - Human only.
- **Intermediate hosts:**
  - Cattle (Cow and Buffalo).

D. Ameera Al-Qadasi

- ***Taenia solium***

- **Scientific Classification**
  - Kingdom: Animal
  - Subkingdom: Metazoa
  - Phylum: Platyhelminthes
  - Class: Cestoidea
  - Subclass: Cestoda
  - Order: Cyclophyllidea
  - Family: Taeniidae
  - Genus: *Taenia*
  - Species: *Taenia solium*

- **Disease:**
  - Taeniasis *solium* (a type of helminthiasis) or pork tape-worm infection.
  - Cysticercosis in human.

- **Habitat:**
  - In ileum of small intestine of man only.
  - Larva can find in muscles and other organs in human.

- **Morphology**:
  - **Adult worm is the same of ***Taenia saginata*** but differ in:**
    1. Size 2–4 meters long.
    2. It has 700-1000 segments.
    3. Scolex has rostellum and two rows of hooks.
    4. Testes about 200, and ovary trilobed.
    5. Gravid segment has a uterus with 7-13 lateral branches.

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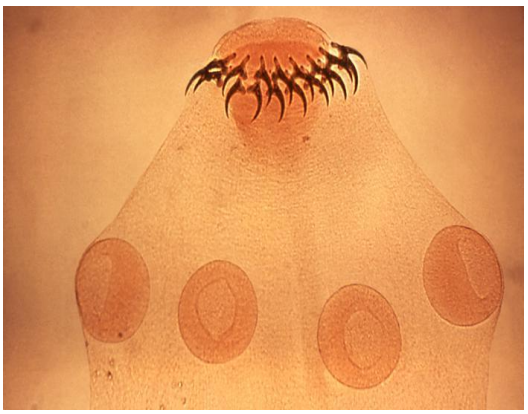

Scolex of *T. solium*

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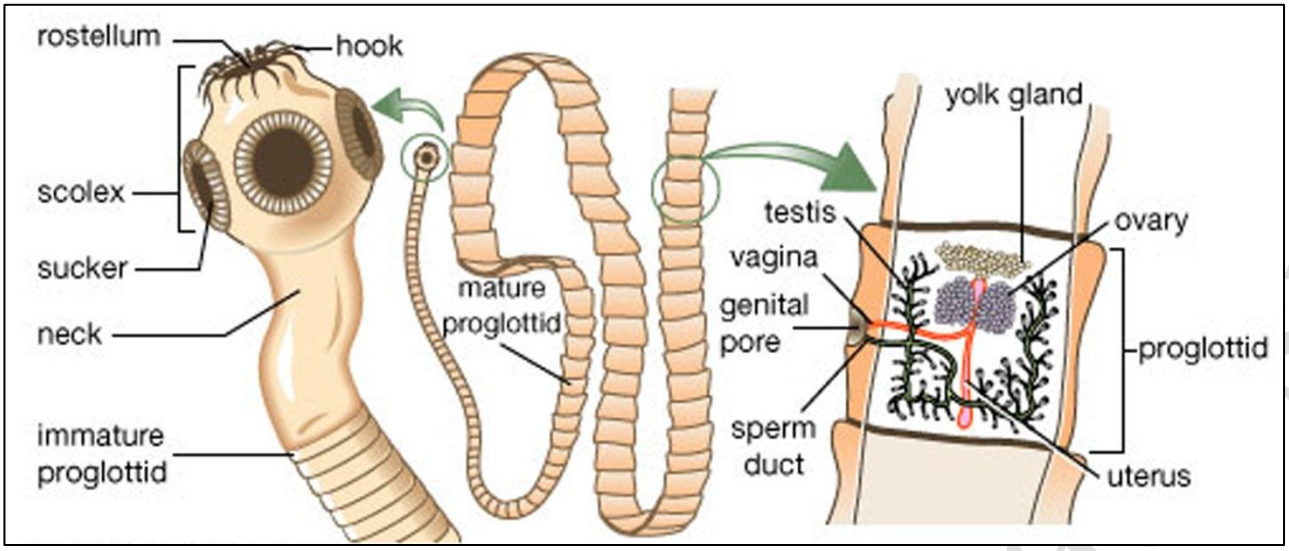
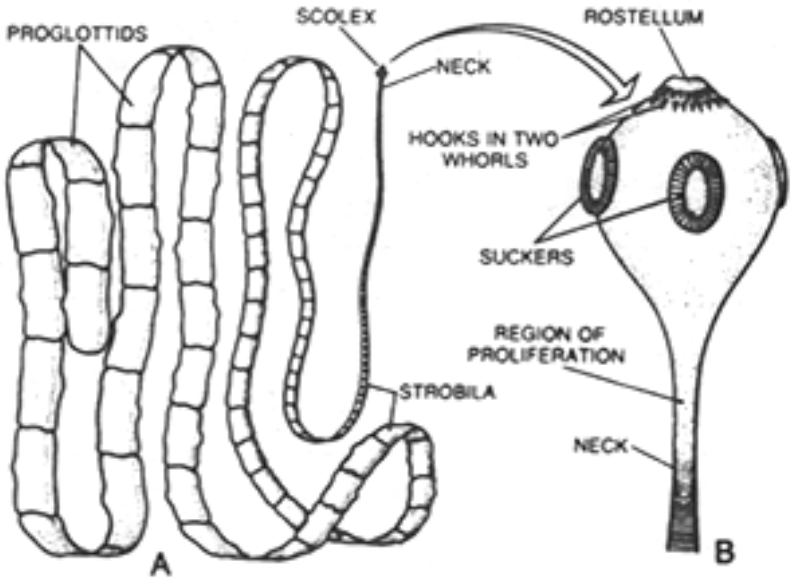
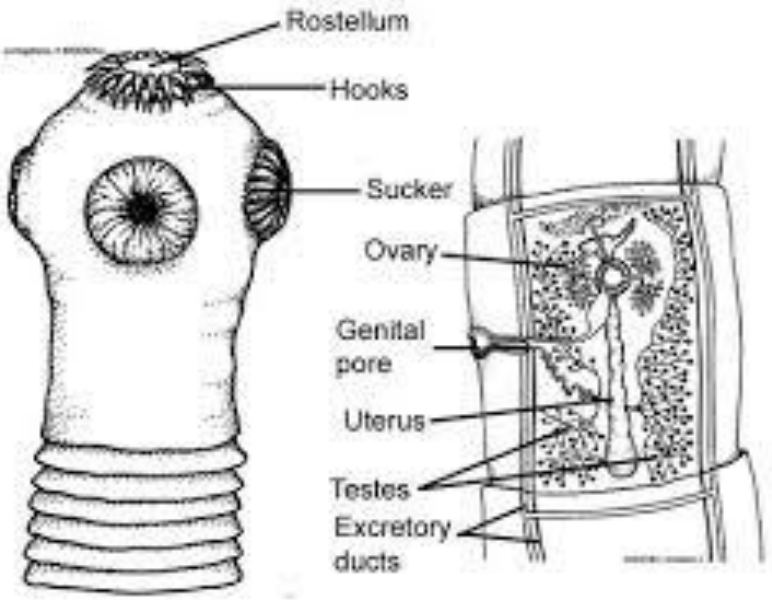
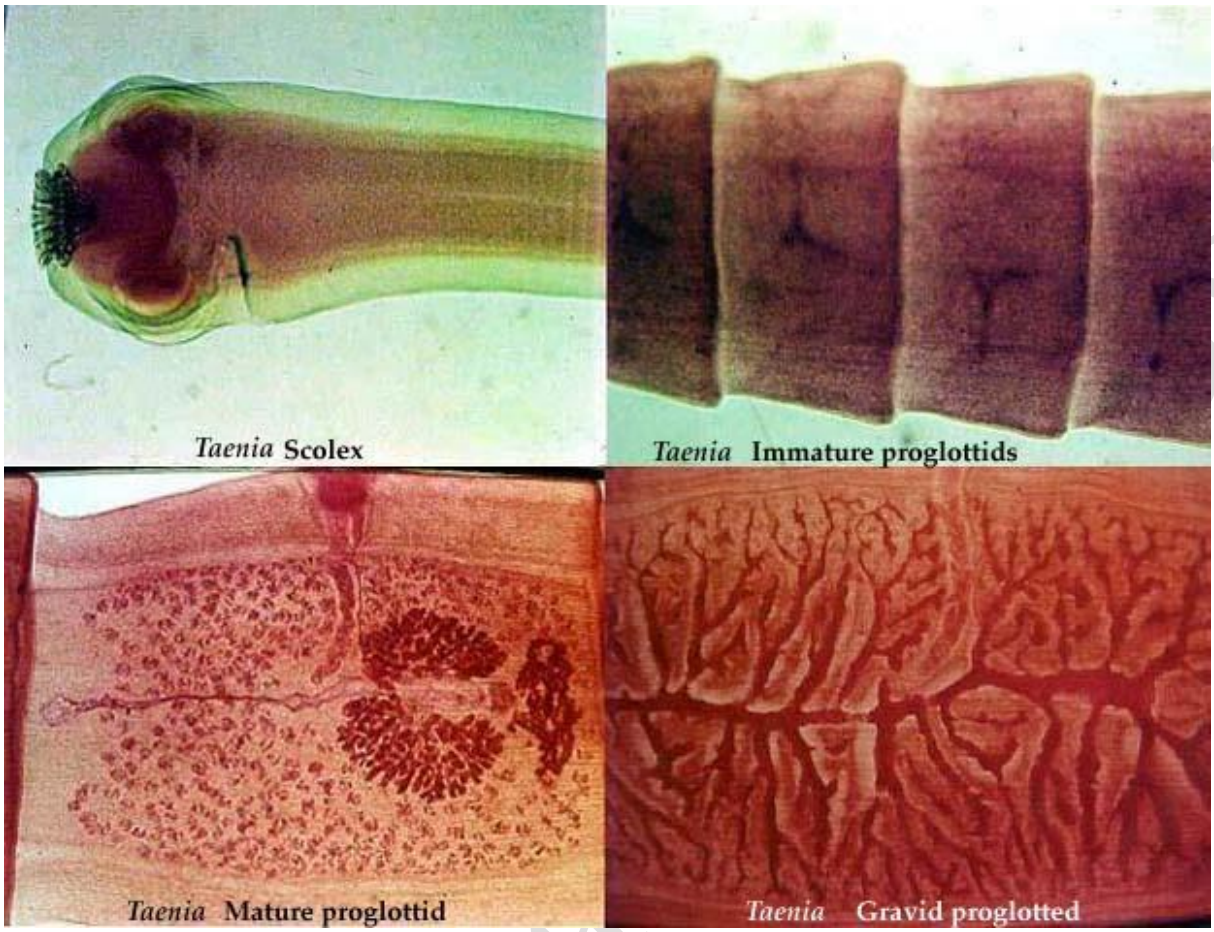




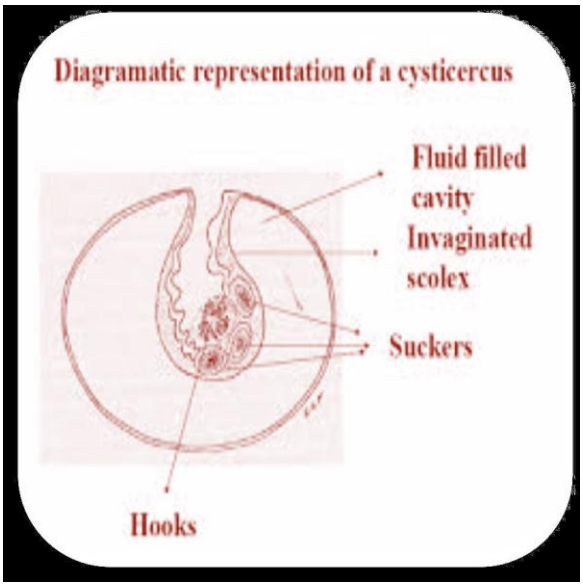
Taenia solium **: A. whole; B. its scolex**





- **Egg of *Taenia solium*:**
  - The same as Taenia saginata egg.
  - Can be differentiated by Ziehl-Neelsen stain ,where *T. saginata* eggs take the stain but *T. solium* egg don't.

- **Larva of Taenia *solium*:**
  - Cysticercus cellulosae.



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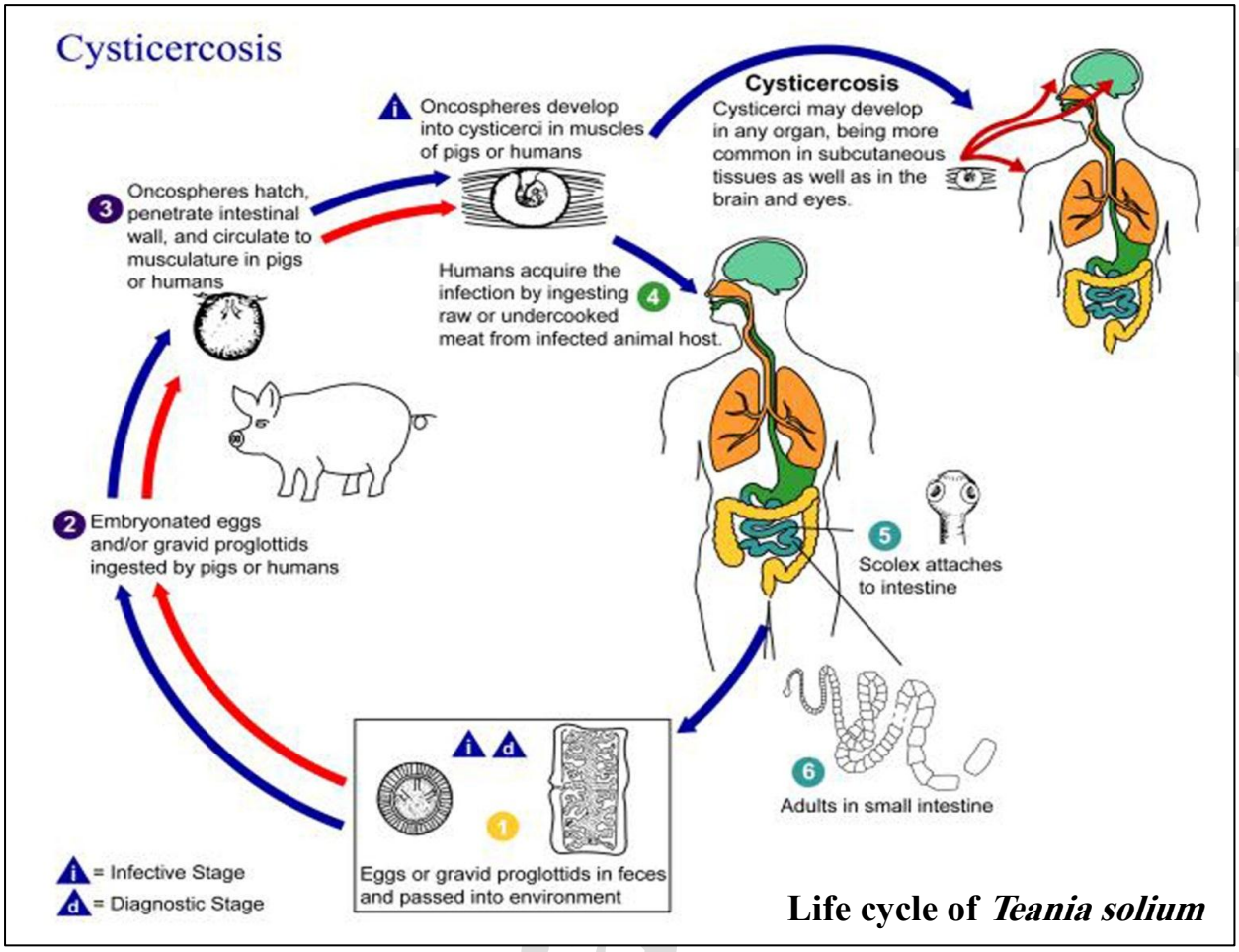
- **Life cycle**


Cysticercosis
Oncospheres develop into cysticerci in muscles of pigs or humans
Cysticercosis
Cysticerci may develop in any organ, being more common in subcutaneous tissues as well as in the brain and eyes.
Oncospheres hatch, penetrate intestinal wall, and circulate to musculature in pigs or humans
Humans acquire the infection by ingesting raw or undercooked meat from infected animal host.
Embryonated eggs and/or gravid proglottids ingested by pigs or humans
Scolex attaches to intestine
Adults in small intestine
Eggs or gravid proglottids in feces and passed into environment
= Infective Stage
= Diagnostic Stage

Life cycle of *Teania solium*

- **Mode of infection:**
  - By eating undercooked or raw meat (pork) containing infective stage (cysticercus cellulosae).
- **Infective stage:**
  - Cysticercus cellulosae (Larva of *Taenia solium*).
  - Egg.
- **Diagnostic stage:**
  - Eggs and gravid segments.
- **Definitive host:**
  - Human only.
- **Intermediate hosts:**
  - Pig and sometimes man.

D. Ameera Al-Qadasi